Spinning Reserve from Supervisory Thermostat Control

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for

Transmission Reliability Research Review

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Goals

- **Current NERC rules dictate spinning reserves to come from generation that is unburdened, able to respond immediately, and become fully responsive in 10 minutes**
- **The project consists of using responsive loads to provide spinning reserves to address electric reliability issues**
- **Quantify residential and commercial cooling loads that can contribute to spinning reserves**
- **Economics of providing Spinning Reserve from responsive loads**

Opportunity

- **The project would provide flexibility, alternatives to free up generation used to supply spinning reserves**
- **NERC and utilities are interested in responsive loads to supply spinning reserves**
- **Benefits include increased energy management capability**
- **Most of the hardware/software already exists. It is a matter of determining the next few steps in bringing idea of responsive loads to provide spinning reserves to fruition**

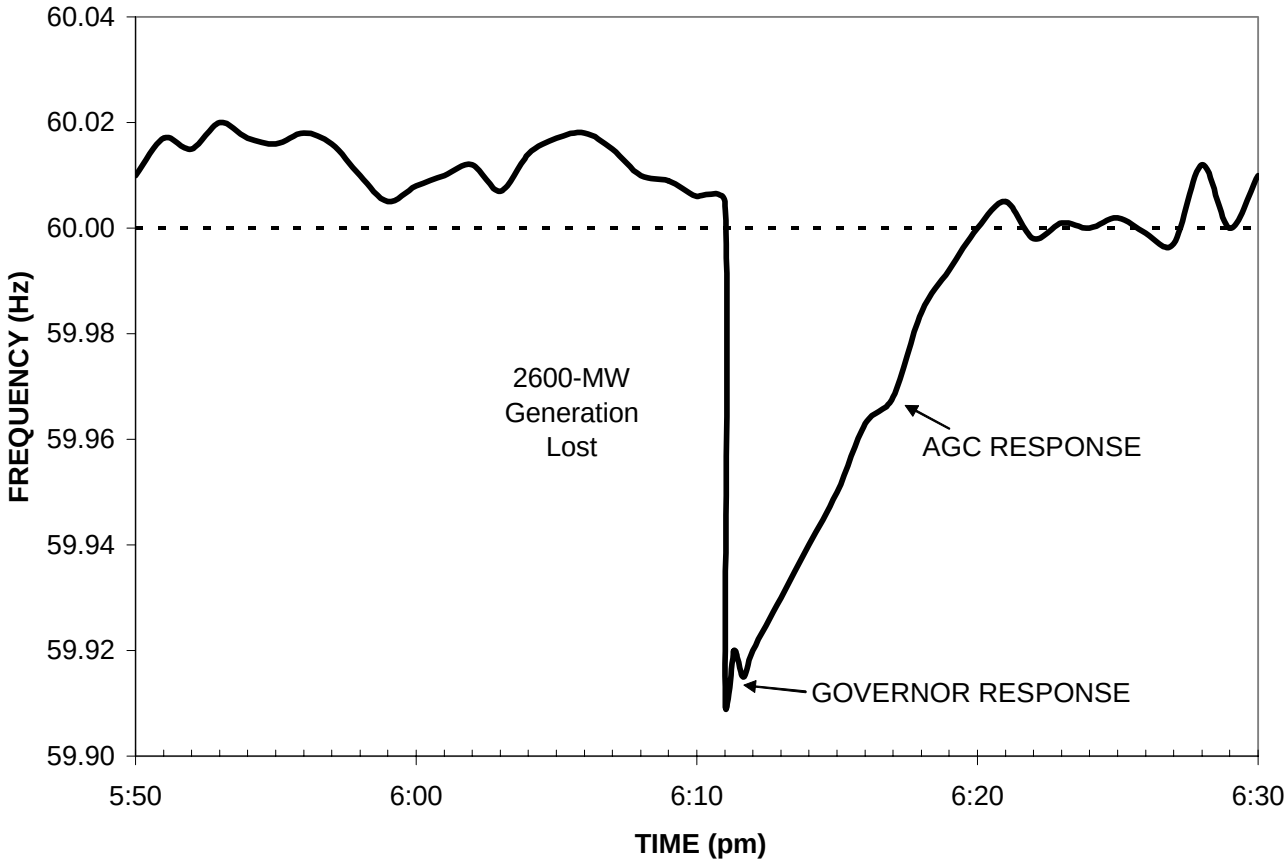
Outline

- **Quantify Hourly, Daily, and Seasonal Packaged Terminal Air conditioner (PTAC) Load Contribution to Spinning Reserves**
- **Spinning Reserve Technical Requirements**
- **Size of Spinning Reserve Resource from Thermostat Controls**
- **Correlation between hourly PTAC load and hourly utility system load (TVA, CA ISO, NE ISO Data)**
- **Utility Pricing Data (spinning and ancillary load)**
- **NERC requirements**
  - **Information from Field Data to serve NERC Control Area request for waiver**
- **Phase II**
  - **LIPA/Carrier Data on 17,000 homes**
  - **SCE/Carrier Data from 3,000 homes**
  - **PTAC technical issues**

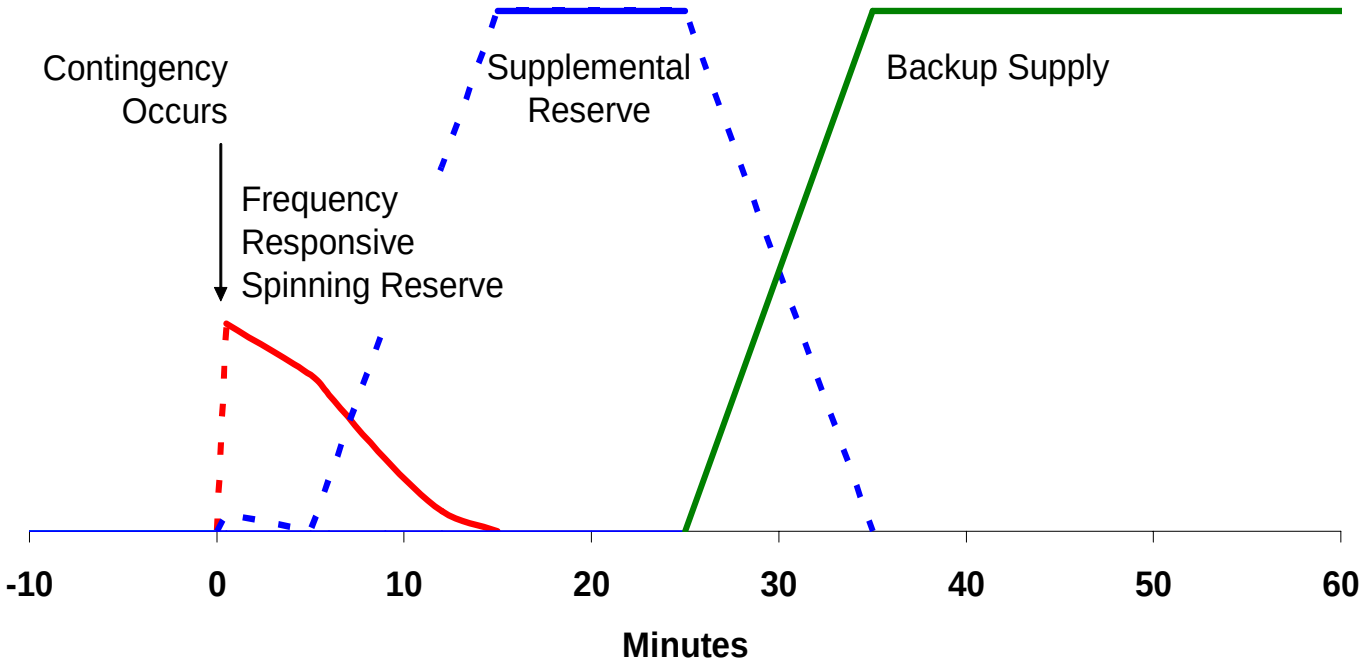
Spinning Reserve Requirements

- **Critical technical requirement is to rapidly restore generation/load balance after a serious contingency (loss of major generator or transmission line)**
- **This restoration can be addressed from either the generation or load side**

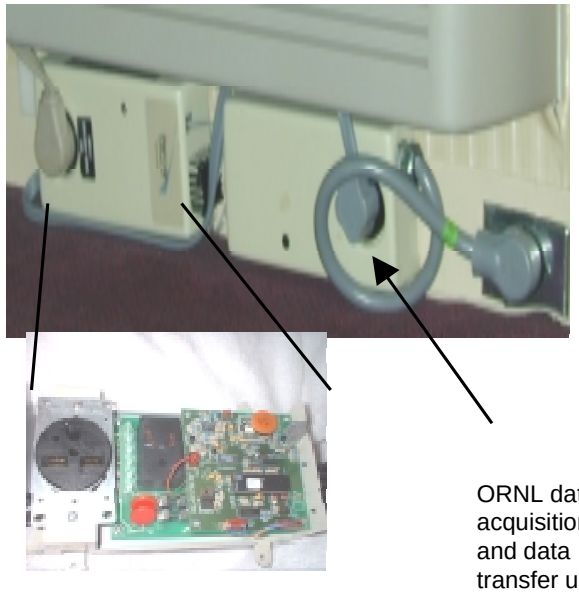
Spinning Reserves Responds Immediately Following Contingency (ERCOT Data)



Spinning Reserve is Quickly Relieved by Supplemental and Backup



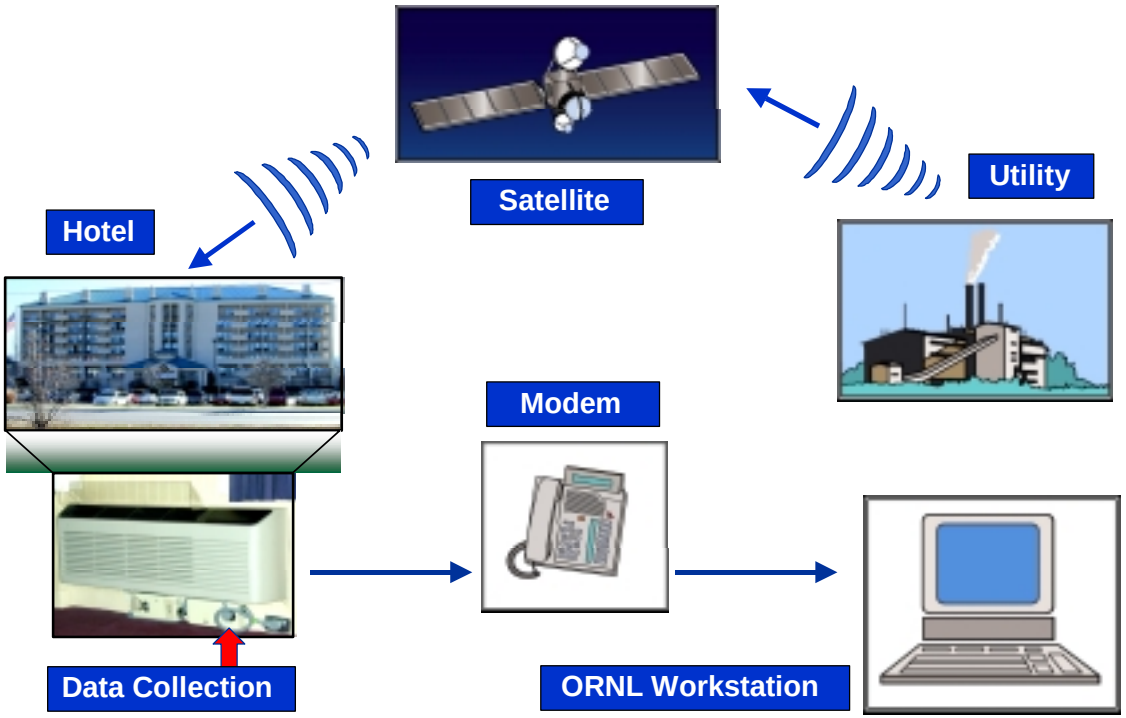
Digi-Log, Inc./ORNL PTAC Supervisory Control Hardware



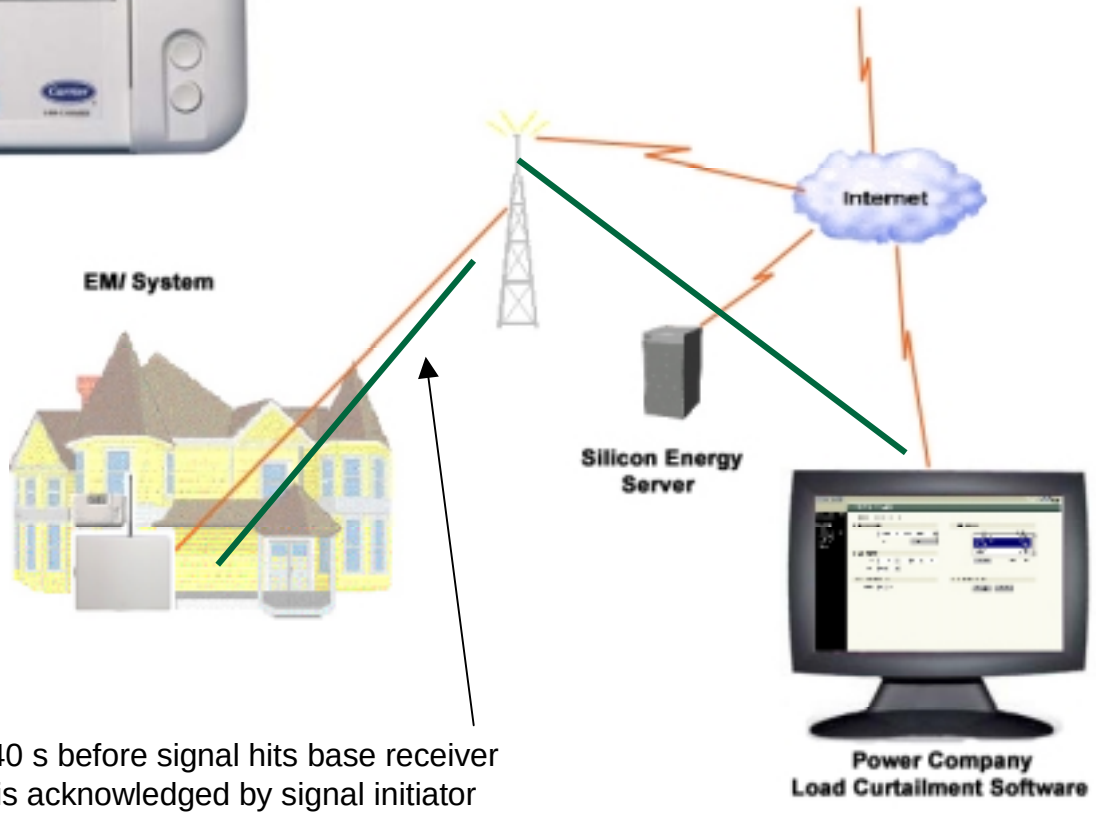
ORNL data acquisition and data transfer unit

New controller designed by Digi-Log, Inc.

Schematic of Digi-Log, Inc./ORNL signal initiation, reception and data collection

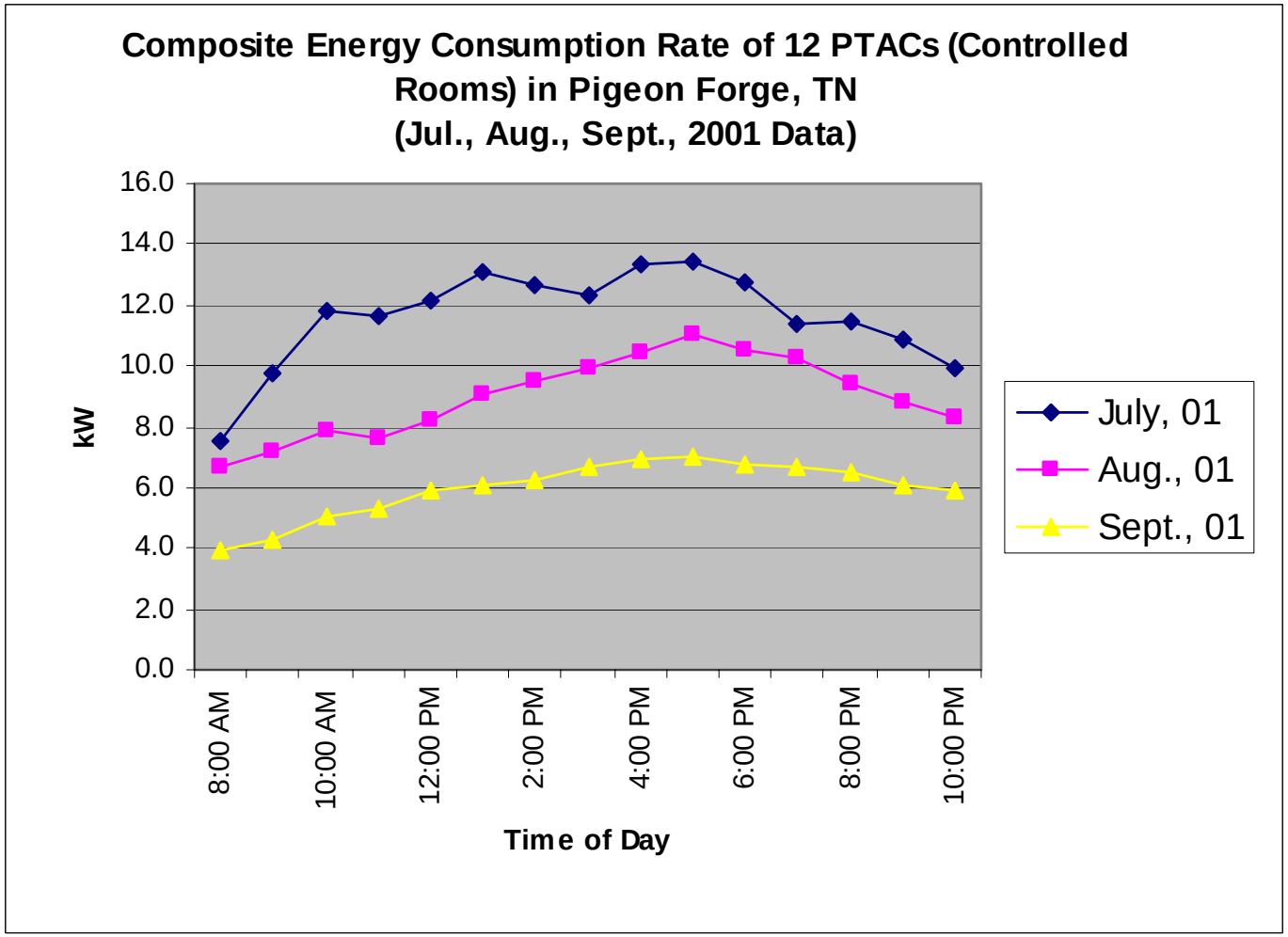


LIPA/SCE/Carrier/Hardware for Residential Thermostats Control

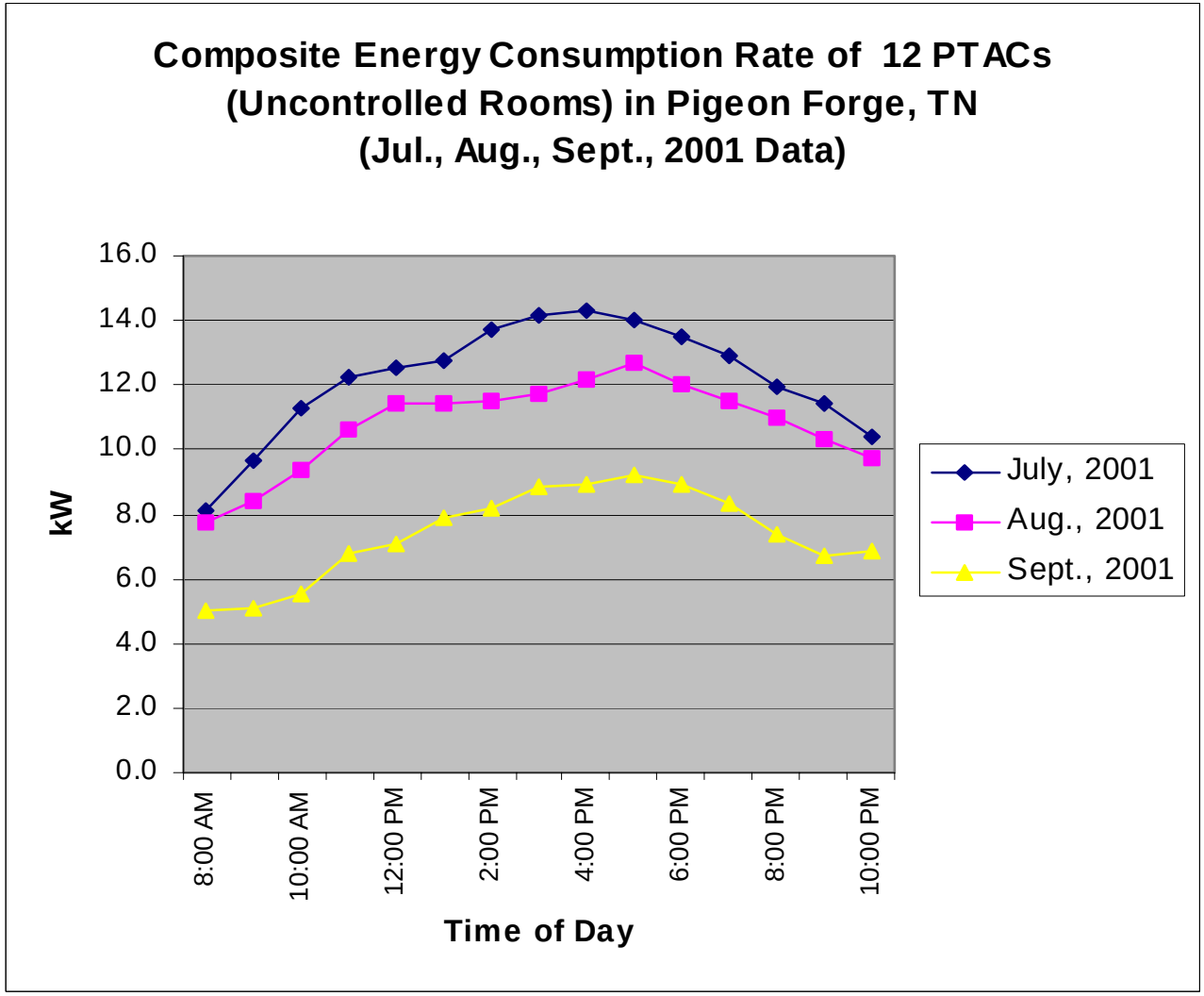


30 -40 s before signal hits base receiver
and is acknowledged by signal initiator

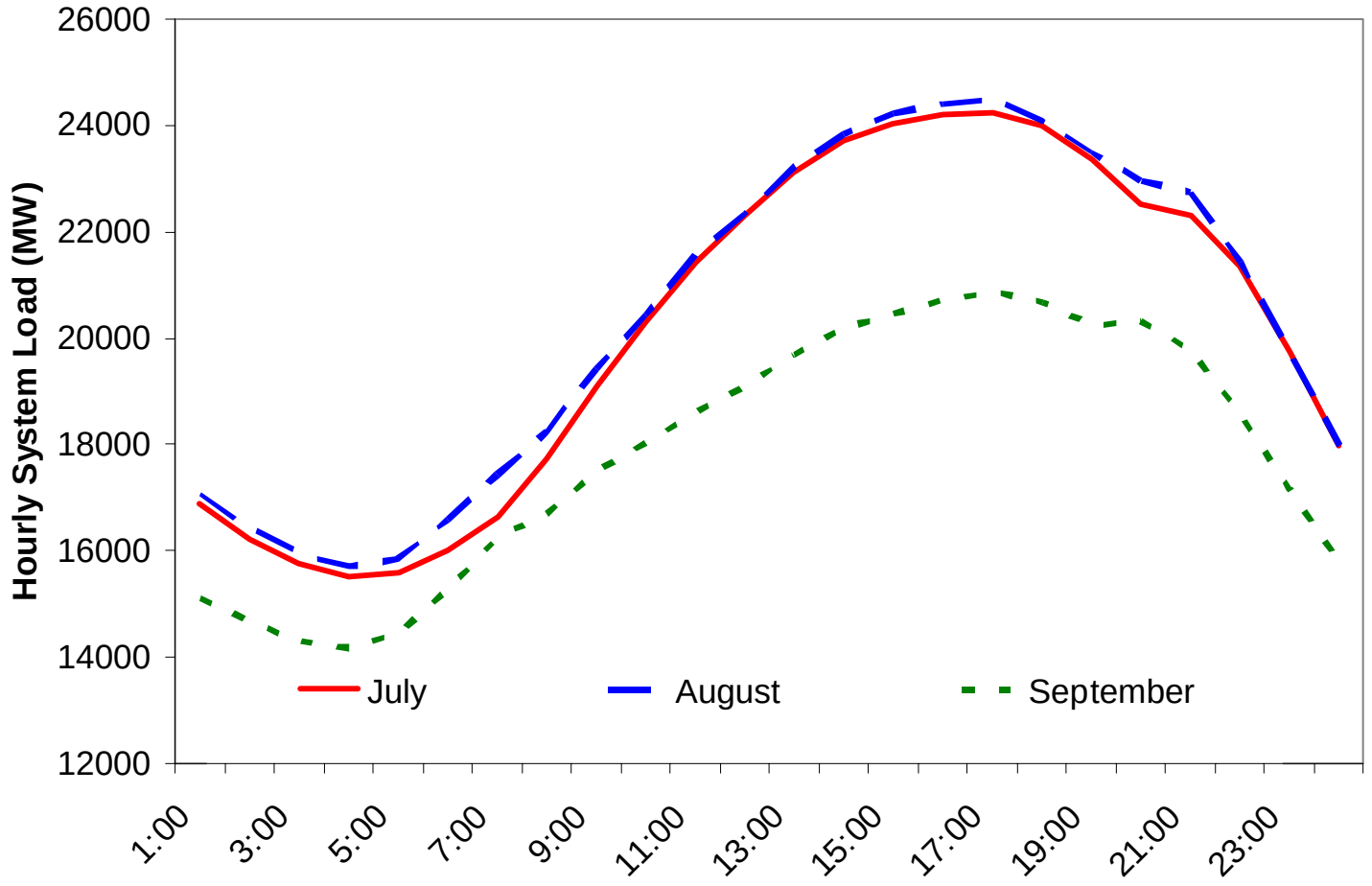
PTAC Averaged Hourly Summer 2001 Load (controlled rooms)



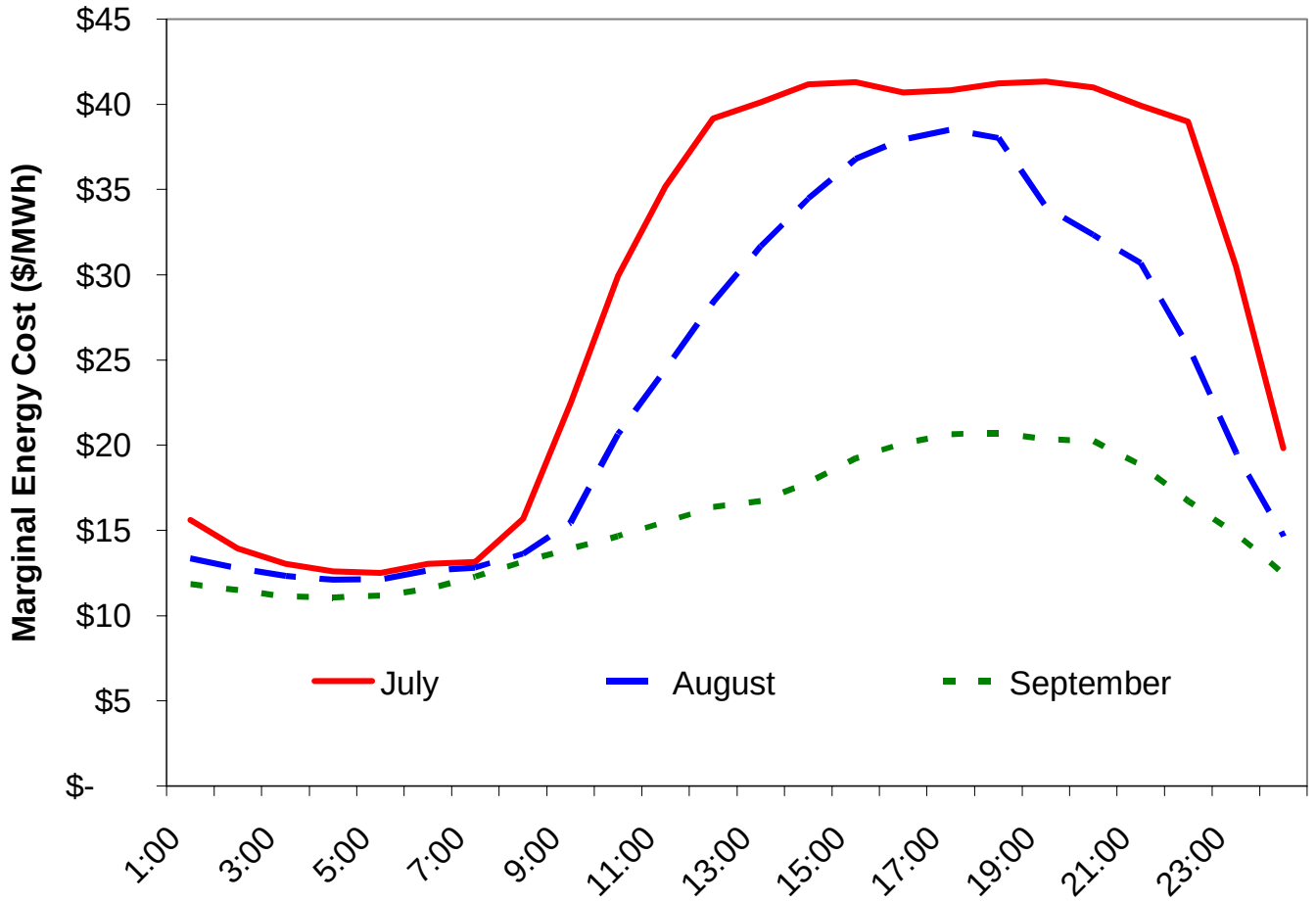
PTAC Averaged Hourly Summer 2001 Load (uncontrolled rooms)



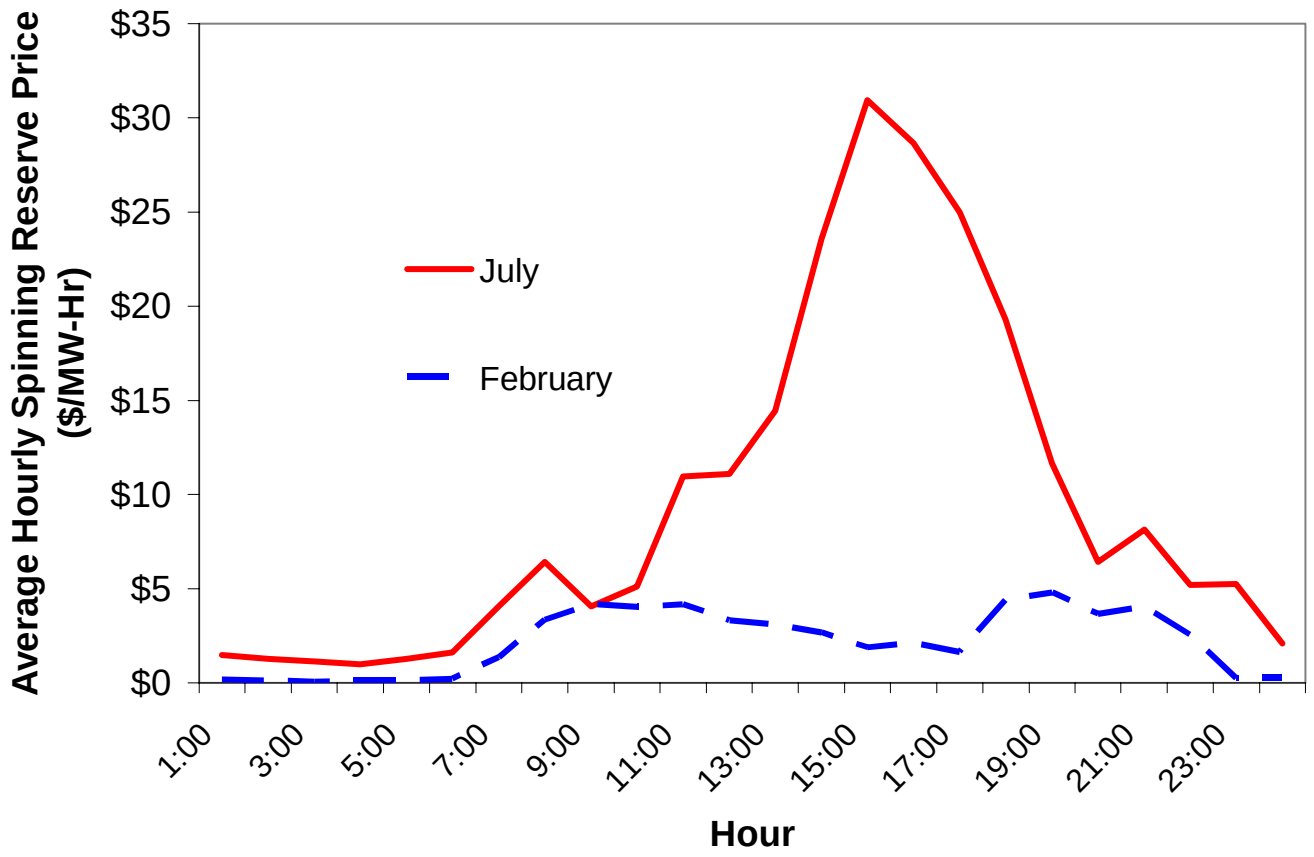
TVA Average Hourly System 2001 Summer Load Consistent with PTAC Loads



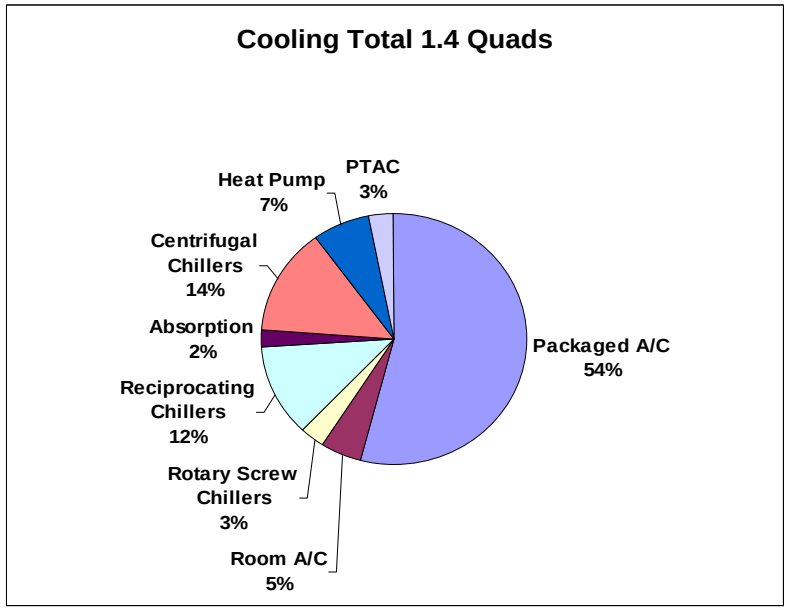
TVA Hourly Averaged System Marginal Energy Cost (Summer 2001)

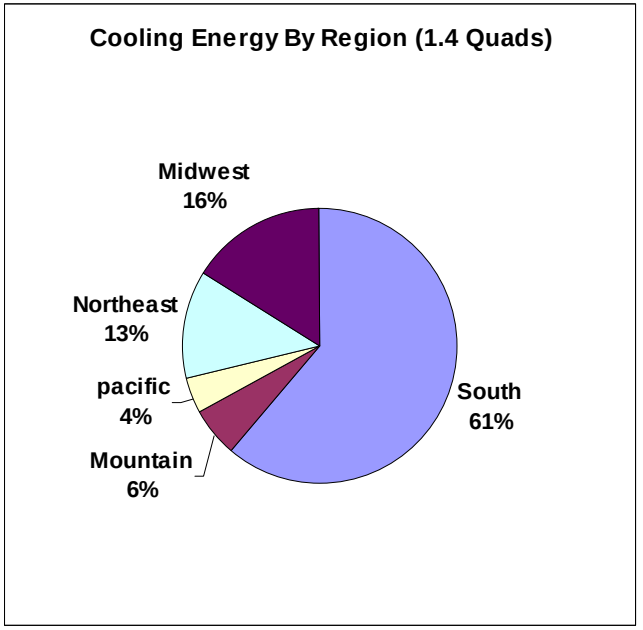


CAISO Average Hourly Spinning Reserve Prices for February and July 2002



Resource Size - Commercial (PTAC) Market

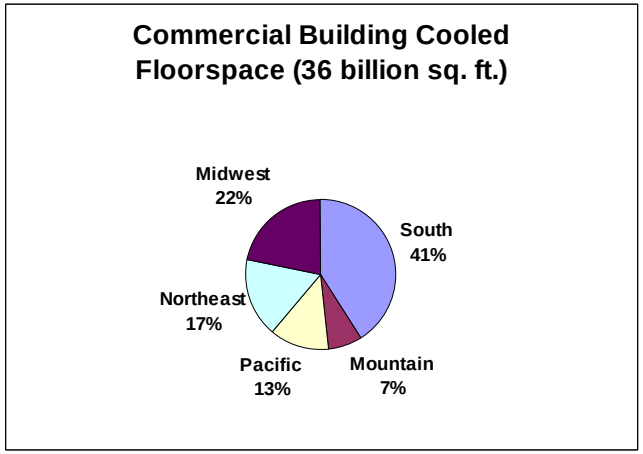




Type	%	Quads
Packaged A/C	54	0.756
Room A/C	5	0.07
Rotary Screw Chillers	3	0.042
Reciprocating Chillers	12	0.168
Absorption	2	0.028
Centrifugal Chillers	14	0.196
Heat Pump	7	0.098
PTAC	3	0.042
Total	**100**	**1.4**

1 Quad = 10^{15} BTU = 2.93 x 10^{11} Kw-h

Source: Energy consumption Characteristics of Commercial Building HVAC, Vol. 1, April 2001. Prepared by A.D. Little, Inc. for U.S. DOE



PTAC Economics

Typical PTAC Data

1480 watts cooling	**1.48** kw	12 hours/day	compr. running time	**7**	cooling months
3360 watts heating	**3.36** kw	8 hours/day	heater running time	**5**	heating months
0.059 $ per KWH	**163** units	Occupancy :	89 %		

Cooling

Per Unit	
17.76 kwh/day	$1.05 per day
480.5146 kwh/month	$28.35 per month
3363.602 kwh/year	$198.45 per year

Savings, Cooling Mode : **28** %

Savings Per Unit	
4.884 kwh/day	$0.29 per day
132.1415 kwh/month	$7.80 per month
924.9905 kwh/year	**$54.57** per year

Heating

Per Unit	
26.88 kwh/day	$1.59 per day
727.2653 kwh/month	$42.91 per month
3636.326 kwh/year	$214.54 per year

Savings, Heating Mode : 28 %

Savings Per Unit	
7.392 kwh/day	$0.44 per day
199.998 kwh/month	$11.80 per month
999.9898 kwh/year	**$59.00** per year

Installed Cost of Digi-log controller = $299
Energy Savings = $114/year
Simple payback = 2.62 yrs for custom-made units
Assembly-line units to cost at least an order of magnitude less ~$30
In this case, simple payback ~ 1/4 year

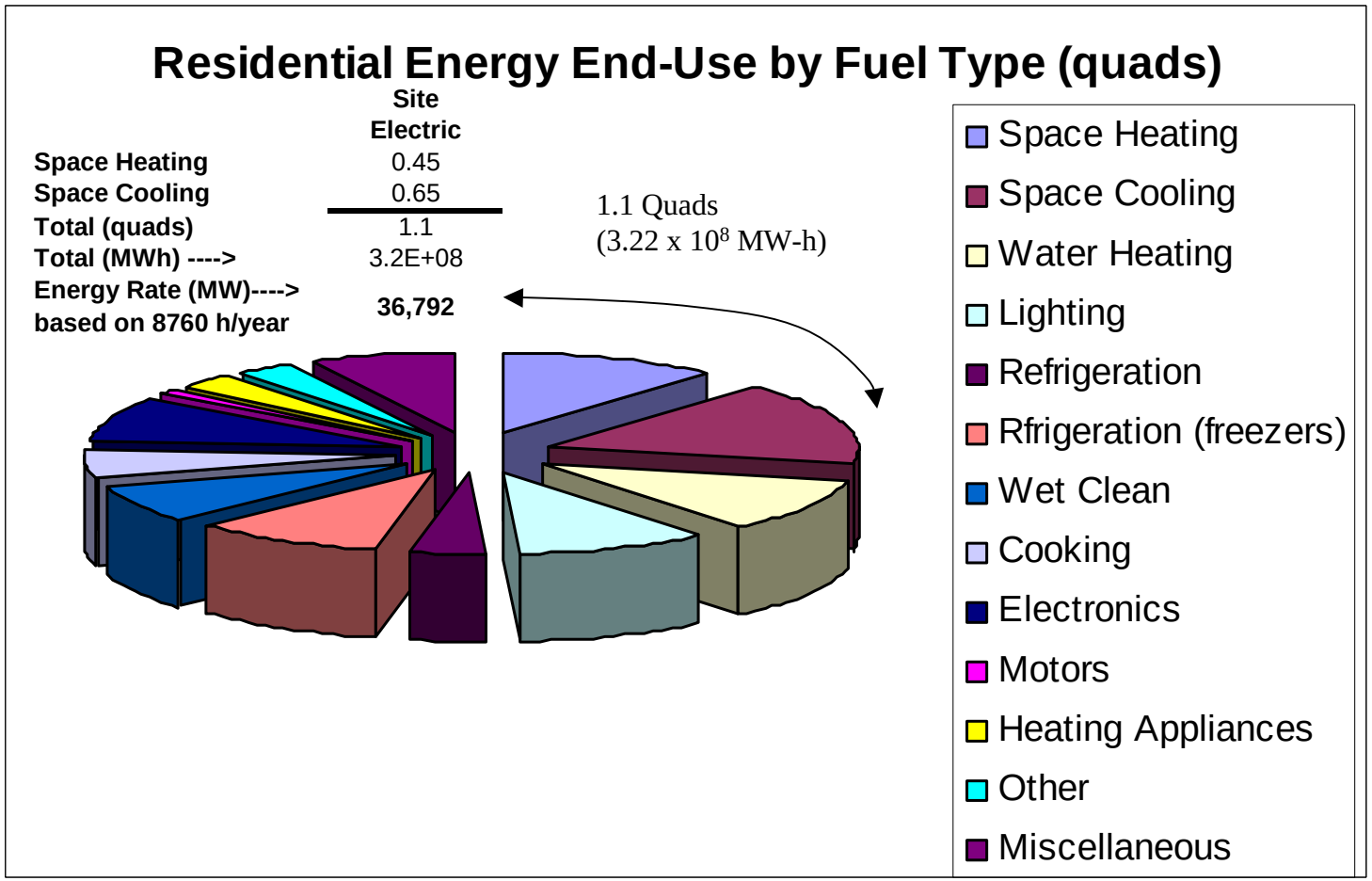
Total Annual

		Per Unit	
Usage :	6999.928 Kwh/year	$257.45	per year
Savings:	1924.98 Kwh/year	**$113.57**	per year

PTAC Economics (cont'd)

- **Gas Turbine generation cost is ~ $500/kW**
- **Cost of pager technology to extract spinning reserve from PTAC ~ $50**
- **Each PTAC contributes 1.1 kW**
- **$46/kW for spinning reserve from responsive load is *highly* attractive to utilities relative to generation using Gas Turbines**
- **Economical to end-user and utilities**

Resource Size- Residential Market



Source: 2000 BTS Core Databook, Office of Energy Efficiency and Renewables, U.S. DOE, August 7, 2002

Resource Size - Summary

- **Residential** **37,000 MW**
- **Commercial (PTACs only)** **3,000 MW**

NERC Requirements

- **Spinning reserves must come from generation that is on-line, not fully loaded, frequency responsive, able to respond immediately, and become fully responsive in 10 minutes**
- **Current NERC rules do not allow loads to supply spinning reserves**

Spinning Reserves: future direction

- **NERC is open to alternative choices for providing spinning reserves**
- **Ongoing work at NERC Policy 10 and Policy 1 committees recognize utility interest in responsive load providing spinning reserves**
- **Opportune time for DOE, utilities to study potential for load to provide spinning reserves**

Summary: Phase I

- **Commercial sector**
  - **quantified spinning reserve/PTAC (1.1kW)**
  - **at least 3,000 MW from PTACs that can contribute to spinning reserves**
  - **quantified hourly and seasonal contribution of load toward spinning reserve**
  - **matched hourly, seasonal PTAC load in actual field demonstration with hourly, seasonal load utility loads (TVA, CAISO)**
  - **conducted economic analysis of spinning reserves and energy benefits: favorable ROI**

Summary: Phase II

- **Residential Sector**
  - **Our discussions with LIPA, Southern California Edison, Carrier Corp., Consolidated Edison, indicate strong interest in technical viability of generating spinning reserves from loads in residential buildings**
  - **Residential buildings sector comprises 105 million units with yearly averaged cooling loads estimated at 36,000 MW, more than 10 times the commercial PTAC load**

Summary: Phase II (cont'd)

- **Residential Sector**
  - **Loads controlled with Carrier Comfort Choice represent a large resource that is highly correlated with power system load**
  - **Large pool of installed equipment readily available**
  - **LIPA data on 17,000 homes has been received**
  - **SCE data on 3,000 homes is being negotiated prior to release**
  - **Existing load curtailment and monitoring technology has been customized for ISO and utilities**

Summary: Phase II (cont'd)

- **Quantify residential cooling and heating loads that can contribute to spinning reserve in LIPA, SCE territory**
- **Identify aggregation, communication, control, and monitoring issues**
- **Response time of ISO issued signals and successful acknowledgement and execution**
- **Technical feasibility of PTAC units and comparison with performance of commercial residential thermostat controllers**

DOE Budget/Cost - Sharing

- **FY'02**

DOE	**$80K**
Digi-Log, Inc.	**$90K**
NYSERDA pledge	**$15K**
DOE share of cost =	**43.2%**

- **FY '03**

DOE (recd.)	**$50K**
DOE (pending)	**$70K**
Carrier Corp./LIPA (equip.)	**$5,400K**
Carrier Corp./LIPA (Software/Ops., etc.)	**$5,200K**
NYSERDA (funds to LIPA)	**$15K**
DOE share of cost =	**1.12%**

Active participants

- **Alex Nyilas, LIPA**
- **Dan Zaweski, LIPA**
- **Joe Lobes, Applied Energy Group, N.Y**
- **Michael Marks, Applied Energy Group, N.Y**
- **Peter Douglas, NYSERDA**
- **Ken Winters, Digi-log, Inc, TN**
- **Al Carpentier, Digi-Log rep. In NY**
- **Mike Hervey, LIPA Systems Operation**
- **Seth Hulkower, LIPA Systems Operations**
- **David Lawrence, NYISO**
- **Richard Kessel, Chairman, LIPA**
- **Mark Martinez, SCE Manager, Load Control Programs**
- **Lauren Kolb, dir. Product strategy and Marketing, Carrier, Corp.**
- **Ray Archacki, Jr., System Architect, ComfortChoice, Carrier Corp.**
- **Margret Spurlin, ORNL/UT-Battelle Tech. Transfer Office**